

# PATENT SPECIFICATION

Inventor: GARWOOD W. FERGUSON

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## COMPLETE SPECIFICATION

### Improvements relating to Hypodermic Injection Devices

We, BECTON DICKINSON AND COMPANY, a corporation of the State of New Jersey, United States of America, of Stanley and Cornelia Streets, East Rutherford, County of Bergen, 5 and State of New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and 10 by the following statement:—

This invention relates to hypodermic injection devices and although it is primarily designed for the injection of medicament at skin penetrating pressures and velocities, it is 15 also capable of being used with apparatus employing skin piercing needles.

It is an object of the invention to provide an apparatus which may readily be operated by the physician or patient and in which, 20 apart from associating medicament with the device, substantially no other effort or time-consuming operations will be necessary. In other words, in order to potentialize or cock the apparatus for operation, it will not be 25 necessary to wind or otherwise tension a spring, to associate a flask of compressed fluid, such as CO<sub>2</sub>, with the apparatus, or otherwise to place the unit in a condition where it may perform an operative stroke. Instead, an 30 apparatus is furnished which, at all times, will be ready for substantially instantaneous operation without any preparatory technique being resorted to.

A further object is that of providing an injection device, the working stroke of which will be substantially uniform throughout its entire range with no diminution in power. Therefore the medicament may be discharged under substantially uniform and constant conditions. 35 Moreover, the present apparatus will function in a desirable and satisfactory manner regardless of whether the maximum or a smaller amount of liquid is to be discharged.

According to the invention, the hypodermic injection device is provided with electro-

magnetic mechanism for expelling liquid medicament therefrom. For this purpose a medicament-receiving chamber may be disposed at one end of a bore in which a plunger works, and the plunger may form part of or 50 be connected to the armature of the electromagnetic mechanism so that upon energisation of the said mechanism, the plunger will be moved to expel medicament from the chamber. The medicament-receiving chamber may 55 comprise an ampoule or cartridge adapted to be mounted on one end of the device so that the plunger will co-operate with a stopper in the ampoule or cartridge, and the stopper will then act in the manner of a piston during 60 the expulsion of the medicament. The medicament-receiving chamber may have an outlet aperture of minute cross-section, or two or more such outlet apertures, where the 65 device is intended for hypodermic injection without the use of a skin piercing needle. Alternatively, the outlet from the medicament-receiving chamber may lead into a skin-piercing needle.

In order that the invention may be clearly understood and readily carried into effect, two constructions for hypodermic injection devices according to the invention, designed for use without skin piercing needles, will now be more fully described, by way of example 75 only, with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal sectional view of one construction of the injection device, and

Figure 2 is a somewhat enlarged and fragmentary view also in section, of a second construction of the apparatus.

The present invention has primary reference to that type of injection device which is employed to inject medicament into the tissues without the aid of a skin-penetrating needle. In other words, the liquid to be injected is discharged in a stream of relatively minute cross-sectional area and this discharge is effected with such velocity that the skin is 90

penetrated and the medicament is lodged in the underlying tissues in a desired pattern. With this in mind, the medicament-receiving chamber has been shown in the form of a cartridge or ampoule extending beyond the main body of the device. It will be understood that numerous other structures for containing and delivering the medicament might be employed. Therefore, the specific constructions shown in the drawings and the description are to be taken as illustrative only with regard to the medicament-enclosing structure.

Referring to the drawings, the numeral 5 indicates the body of an ampoule or cartridge which body is hollow and contains medicament. The outer end of this body is formed with a discharge orifice 6, or it may have two or more discharge orifices, of minute cross-sectional area. The upper or inner end of the body conveniently terminates in a retaining flange 7 and a stopper 8 seals the interior of the body. This stopper may be formed of rubber or similar material and is conveniently impregnated with a lubricant or is otherwise treated so that it will not bind against the surfaces of the bore of the body 5.

To secure the ampoule or cartridge 5 against movement with respect to the body of the device, a loading cap in the form of a retaining ring 9 is connected for example by a screw-threaded connection with the forward end portion 10 of the assembly. As shown, this ring will engage with the flange 7 of the body 5 to prevent relative movement between the parts. The forward portion 10 of the assembly is secured by, for example, screw threads with the cylindrical body 11 of the assembly. The rear end of the body 11 is closed by a cap 12. The parts 10, 11 and 12 are formed of non-magnetic material, conveniently brass.

Within the case 11 a solenoid assembly is disposed. This conveniently includes a cylindrical body 13 to which end caps 14 and 15 are secured. The cap 14, as shown, may have an extension 16 having a screw-threaded connection with the forward body portion 10, to prevent relative movements of the parts. The body 13 and caps 14 and 15 are preferably formed of iron, and they enclose the windings of a solenoid 17. In turn these windings enclose a tube 18 providing a solenoid core. This tube is conveniently formed of brass. Fibre washers or spacers 19 may be disposed adjacent to each end of the windings 17 and interposed between the same and the caps 14 and 15.

The forward portion 10 of the assembly is formed with a bore 20, which is aligned with the stopper 8 when a cartridge or ampoule is mounted by the device. Reciprocable within the bore 20 is a plunger 21, which is also guided for movement by passing through the bore of a stop element 22 disposed within the solenoid core. The stop element is preferably formed of soft iron. The plunger 21 should

be non-magnetic and is therefore preferably formed of brass.

Attached to plunger 21 in any suitable fashion is an armature 23 formed of soft iron or any other proper metal. The armature 23 conveniently has at its rear end a flange or head portion 24, and a spring 25 is interposed between the cap 15 and the head portion and normally urges the armature to assume a position as shown in Figure 1. The cap 12 mounts a casing 26 enclosing a switch structure which may be operated by an actuator 27 extending beyond the cap. A stop element 28 is affixed to the casing 26 in lines with the path of travel of the plunger 23 so as to arrest outward movement of the parts. Leads 29 extend through the casing and are connected to the switch structure and to the windings of the solenoid 17.

Similarly the structure shown in Figure 2 may mount a medicament-containing cartridge or ampoule 5 upon its outer end portion 30 by means of a holder in the form of a ring 31. The outer portion 30 has a screw-threaded attachment with a cap 32 which, in conjunction with a cylindrical body portion 33 and a rear portion 34 provides the main part of the assembly. Within the space thus defined, the windings of a solenoid 35 are disposed. A plunger 36 is movable through the bore of the part 30 and is attached to an armature 37.

Again in this form of the device the parts 30 to 34 inclusive and 36 are preferably formed of non-magnetic material such as brass. A stop 38 of soft iron co-operates with the armature 37 which is likewise conveniently formed of this metal. The core 39 similar to the core 18 of the first embodiment may be in the form of a tube having an internal diameter slightly in excess of the external diameter of an armature movable within the same. This core may be formed of brass. Washers 40 may be interposed between the ends of the winding 35 and the cap 32 and the body portions 34. In order to avoid unnecessary illustration, the spring, switch, and incidental portions of the apparatus have not been shown in Figure 2.

In employing the apparatus of the invention, the chamber which receives the medicament will first be charged with proper liquid and thereafter the leads 29 will be connected to a source of suitable current supply. As shown, such charging will simply embrace the association of a cartridge or ampoule 5 with the outer end of the device by bringing the parts into abutting position and thereafter applying and tightening the holder rings 9 or 31. It is of course obvious that other forms of medicament-containing ampoules might be employed. In certain instances the medicament might be retained in the body of the device. According to the needs of a given installation the outer ends of plunger 21 or 36 could be modified in design. In any event with the dis-

- charge orifice or orifices of the assembly firmly pressed against the site of injection, the switch is closed. The resultant flow of current will energize the solenoid to cause the armature to be moved forwardly until it strikes against the stop 22 or 38.
- The magnetic flux will also magnetise the stop member 22 or 38 but will have no effect on the plunger 21 or 36. With the movement 10 of the armature 23 or 37 the non-magnetic plunger will be moved forwardly at considerable speed. With such forward movement, the end of the plunger 21 or 36 will strike against the stopper of the ampoule or other medicament-receiving structure and will cause a piston-like action to occur such that the liquid will be expelled at high velocity and pressure through the minute discharge orifice 6. Thus, the skin and tissues disposed adjacent to the 15 end wall of the cartridge 5 will be penetrated by the medicament. When the switch 27 is released, current flow will be interrupted and under the influence of the spring 25, the parts will return to their initial positions.
- With the parts proportioned and arranged as shown, an initial pull will be exerted as the circuit is closed. Due to the characteristics of the ironclad solenoid and stop, an increasing 20 pull is assured as the plunger moves through its discharge stroke. A maximum pull results as the plunger moves to a position adjacent to its stop. Thus, the rate of discharge of the medicament does not decrease through the working stroke with resultant inefficiency of 25 the injection.
- As previously stated, the injection device may employ a skin-piercing needle, which may be mounted at the outer end of the medicament-receiving chamber or ampoule in any 30 convenient manner. It will be understood, of course, that where a skin-piercing needle is used, the pressure at which the liquid medicament is to be expelled may be substantially less than where injection is to be made without such a needle, and consequently the 35 solenoid or other operative parts may be modified accordingly. It will also be understood that instead of mounting the energising switch on the device itself, this may be a separate unit interposed in the current supply leads, or it may be mounted on any suitable support.
- What we claim is:—
1. A hypodermic injection device, in which 55 electro-magnetic mechanism is provided for expelling liquid medicament from the device.
  2. A hypodermic injection device according to claim 1, in which a medicament-receiving chamber is disposed at one end of a bore in 60 which a plunger works, the said plunger comprising or being connected to the armature of the electro-magnetic mechanism whereby energisation of the said mechanism will cause the plunger to be moved to expel medicament from the said chamber.
3. A hypodermic injection device according to claim 2, in which the medicament-receiving chamber is provided at one end of the body of the device and is in line with the bore, and a solenoid encircles the bore rearwardly 70 of the said chamber, the armature being movable within the bore in response to energisation of the solenoid.
4. A hypodermic injection device according to claim 3, in which a piston-like member is 75 disposed in the medicament-receiving chamber and is displaceable by the armature to expel medicament from the chamber.
5. A hypodermic injection device according to any one of claims 2 to 4, in which a spring 80 is provided for moving the armature in the direction opposite to that in which it is moved electro-magnetically.
6. A hypodermic injection device according to any one of claims 2 to 5, in which an electric 85 switch is mounted on the end of the device opposite to the medicament-receiving chamber and is connected to the electro-magnetic mechanism to control the operation thereof.
7. A hypodermic injection device according to any one of the preceding claims, in which the body of the device has means at one end forming or providing a detachable mounting for a unit comprising the medicament-receiving chamber, which latter is thereby supported 90 beyond the said end of the body.
8. A hypodermic injection device according to claim 3 or claim 4, in which the armature normally extends beyond the solenoid in a direction opposite to the medicament-receiving chamber, and non-magnetic means extend between the armature and the chamber with which the said means cooperates for expelling 95 medicament from the chamber as the armature moves through the solenoid.
10. A hypodermic injection device according to claim 3 or claim 4, in which a member disposed adjacent to the medicament-receiving chamber is adapted to be magnetically energised by the solenoid to attract the armature as the latter is moved forwardly due to energisation of the solenoid and assist in maintaining the armature in its forward position under continued energisation of the solenoid.
11. A hypodermic injection device according to any one of the preceding claims, in which the medicament-receiving chamber has an outlet orifice or two or more outlet orifices of minute cross-sectional area, and the medicament expelling mechanism is adapted to expel 110 the medicament from the chamber through the said orifice or orifices at skin-penetrating velocities.
12. A hypodermic injection device according to claim 1, having its parts constructed 115 and arranged substantially as described with

reference to Figure 1 or to Figure 2 of the accompanying drawings.

For the Applicants:  
GILL, JENNINGS & EVERY,  
Chartered Patent Agents,  
51/52, Chancery Lane, London, W.C.2.

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1 SHEET

This drawing is a reproduction of  
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FIG. 1.

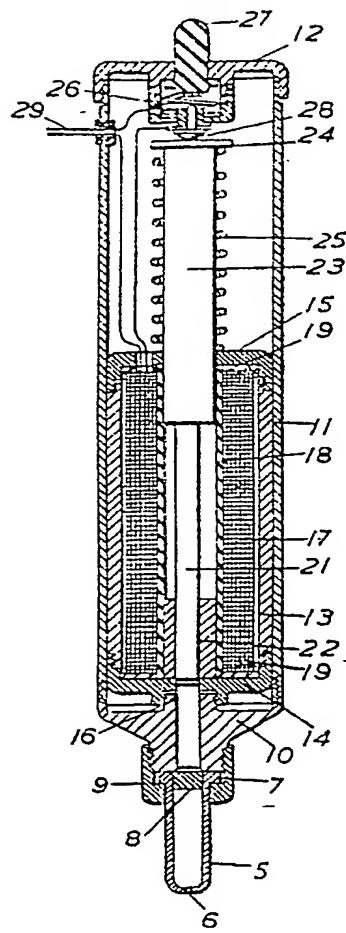


FIG. 2.

